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# Evolution of the Migratory Supply Chain Model

## Abstract

**Purpose:** In 2000, a migratory model for supply chain evolution was proposed. The purpose of this paper is to reflect upon the impact of the original work and provide an updated model to reflect the changing environment for supply chains.

**Design/methodology/approach:** We start by analysing the content of the papers that have cited the original Christopher and Towill (2000) paper. The development of an updated migratory model is informed by the findings from this, and then demonstrated through a case study of the book supply chain.

**Findings:** Despite being the major contribution, the majority of citing papers actually use other parts of the original work and some potential reasons for this are proposed. An extra stage is added to the migratory model, reflecting a customer centric strategy.

**Research limitations/implications:** Given that the migratory model appears under-researched, we identify this as an opportunity for future research and suggest that methods less common in supply chain management are used.

**Practical implications:** The updated migratory model can be used by supply chain managers to develop appropriate supply chain strategies for their organisations, while emphasising that many of the underlying tools to enable this reflect traditional industrial engineering approaches.

**Originality:** The updated migratory model represents a new contribution to understanding the evolution of supply chains.

**Key words:** Lean, agile, leagile, book supply chain, customer centric, omnichannel

## 1. Introduction

The paper by Christopher and Towill (2000) was written at the height of the debate on the virtues and points of conflict between lean processes arising from the popularity of the Toyota Production System (Shingo, 1989, and Ohno, 1988) and agile processes (Nagel and Dove, 1991), and to the practicability of mixing these two types in real world delivery systems (Mason-Jones et al., 2000). Christopher and Towill (2000) was targeted at developing a rationale for bringing these two disparate process types together, in the course of which the Migratory Model was a logical outcome. This debate was much stimulated by contributions involving Fisher et al. (1994) and Fisher (1997). In the latter paper the author pointed out the apparent contradictory characteristics of ‘modern’ supply chains. For example automotive factory throughput times had been slimmed down to 12 hours or less, yet inventory was typically two months sales, and customers still had to wait weeks (or even months) to get the car of their choice.

Fisher (1997) argued strongly that the supply chain total product delivery costs are given by summing physical delivery process costs and marketability costs. The physical costs include

production, distribution, and storage, and marketability costs include all obsolescence and stock out costs. It is thus clear that physical costs dominate lean supply whereas marketability costs dominate agile supply. Of course a particular value stream may consist of many lean processes and also agile processes, in deliberate combination to achieve a specific delivery objective. Thus a lean process is often followed by an agile process (as used in Dell computer supply) and termed “Leagile” supply (Naylor et al. 1999), but an agile process can be followed by a lean process (as found in timber preparation) and termed “Agilean” supply (Towill and Christopher 2007). Note that physical costs dominate lean supply, whereas marketability costs dominate agile supply. This statement yields an immediate clue as the requisite ‘fit’ between customer requirement and supply chain typology.

The build-up supporting the Migratory Model paper is shown in schematic form in Figure 1. Concise definitions from Naylor et al. (1999) were adopted as follows;

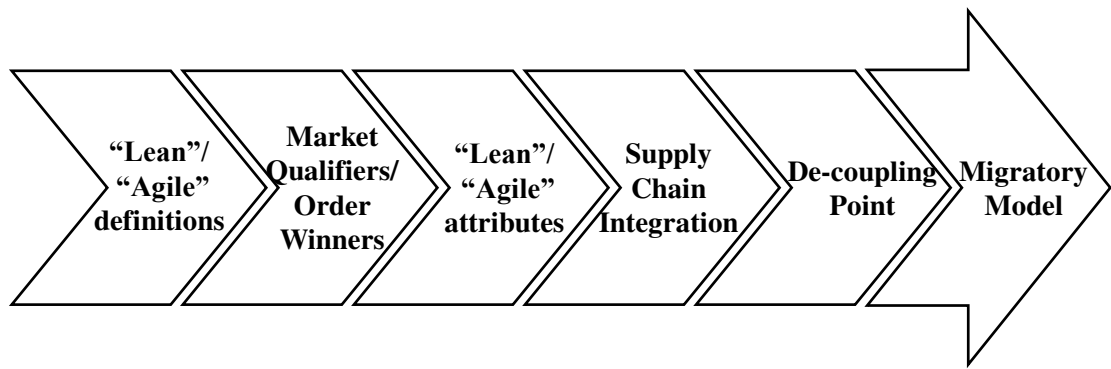
*“Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace”*

and

*“Leanness means developing a value stream to eliminate all waste, including time, and to enable a level schedule”*

The importance of following these definitions with Terry Hill's (1993) Market Qualifier (MQ)/Order Winner (OW) concept is the need for selection of appropriate KPIs consonant with the supply chain types. It was Johansson et al. (1993) who highlighted the importance of focussing on a just a few (preferably only four) KPIs to control delivery value streams, with their preference for Lead Time, Cost, Service Level, and Quality. Having worked on a real world supply chain with 528 KPIs monitored quarterly, they further showed an example whereby 26 highly individualistic measures (i.e. as would be advocated and vigorously defended by "players" within the system) could be readily compressed into four such KPIs which everyone in a particular value stream could identify with the end-to-end performance of the business. The further simple step of identifying the requisite MQs and OWs immediately and succinctly associates the competitive and supply chain strategy (Godsell et al., 2011).

Thus in general, cost is the OW for a lean process, whereas service level is the OW for an agile process. It is possible to associate particular attributes with lean, and with agile delivery, points which will be taken up later when the very relevant Narasimhan et al. (2006) output is discussed in detail. A high standard of integration is necessary for efficient and effective supply chain performance whether lean or agile, as evident from the FORRIDGE design and operating principles (Towill, 1997), which date back to Forrester (1961) and Burbidge (1961).



**Figure 1: Build up to the Migratory Model (based upon Christopher and Towill, 2000)**

It is the decoupling-point which enables the constructive bringing together of lean and agile processes to deliver both customer and supplier value. But there are two decoupling points to be optimally located, for material flow and for information flow (Mason-Jones and Towill, 1997). The former represents a stock holding of, say sub-assemblies, whereas the latter is the transition point between movement based on sales and that based on forecasts. Obviously these two forms of decoupling points help shape the product variety via the postponement philosophy (Lee and Billington, 1994)

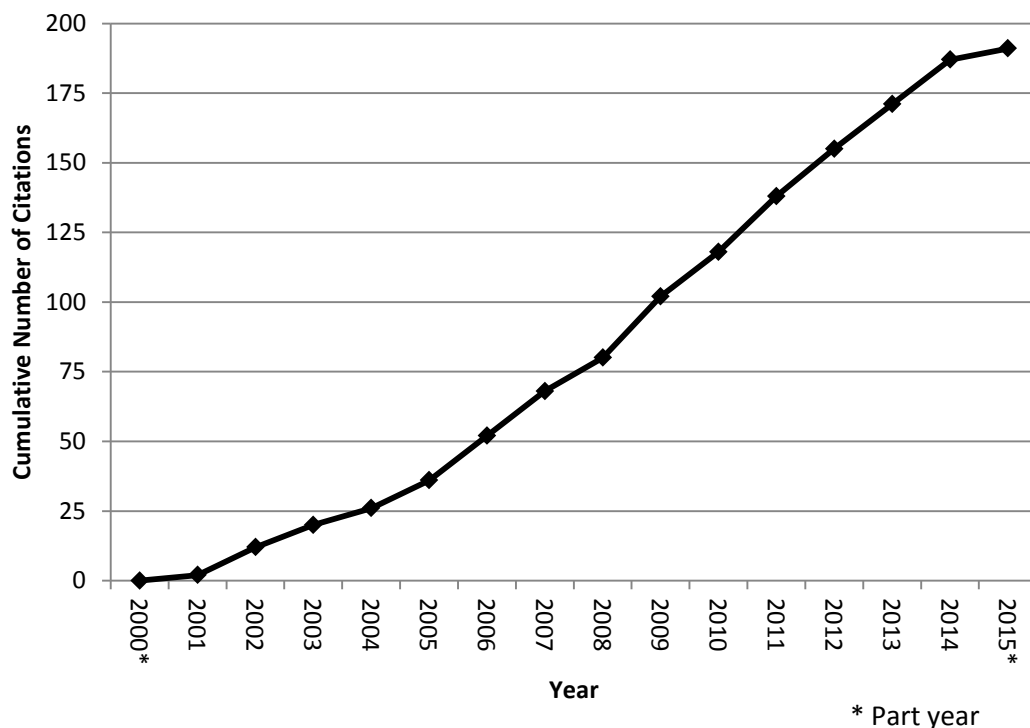
However, it is uncommon for organisations to start their operations from this leagile position. As others have noted (such as Harmonzi, 2001), production methods and their associated supply chains evolve over time and this can also be evidenced through industrial practice, such as the personal computer supply chain example in the original paper. Therefore, a four stage model of this process was developed, and represented the major contribution of Christopher and Towill (2000).

Fifteen years after the original publication of the paper, there is some value in reflecting upon its academic impact and how other researchers have built upon the work through theory testing. We also acknowledge that the world today is significantly different to that at the turn of the century, and therefore update the migratory model to reflect these developments.

## **2. Academic impact of the original paper**

A list of citing publications was taken from Scopus (n = 251) and CrossRef (n = 170), the two databases used by Emerald in relation to citations. From these initial lists, duplicates were removed and the list was further refined so that only English language journal papers were included. Journal papers are often seen as the main publication output (Drott, 1995), while there would be a risk of mis-interpretation if foreign language papers were translated (citing papers were written in German, Portuguese and Chinese). Further, this approach is consistent with other systematic literature review papers (Seuring and Gold, 2012). As a result, a final sample of 191 papers remained for further analysis.

Figure 2 shows the number of citations of the paper per year – where pre-prints were found, they are included in the year recorded on Scopus or CrossRef. Overall the paper is averaging between 14 and 15 citations per year over the past 10 years. It is clear that concepts contained therein continue to influence thinking today, rather than having a short timescale of impact. In terms of where this influence is occurring, the paper is cited in 82 distinct journal titles, with the top 24 shown in Table 1. These 30% account for 70% of the citations. The majority of the journals featuring in the table could be categorised as operations and technology management (Harvey et al., 2010), core aspects of the original paper. The presence of *Supply Chain Management: An International Journal* at the top shows how this journal is building upon content contained within it.



**Figure 2: Cumulative citations per year for Christopher and Towill (2000)**

| <b>Journal Title</b>  | <b>No. of citing papers</b> |
|---|-----------------------------|
| Supply Chain Management: An International Journal                     | 21                          |
| International Journal of Production Economics                         | 14                          |
| International Journal of Production Research                          | 12                          |
| International Journal of Physical Distribution & Logistics Management | 11                          |
| Journal of Manufacturing Technology Management                        | 11                          |
| International Journal of Logistics Systems and Management             | 10                          |
| International Journal of Operations and Production Management         | 8                           |
| Benchmarking  | 6                           |
| Production Planning and Control                                       | 5                           |
| International Journal of Advanced Manufacturing Technology            | 4                           |
| Industrial Management and Data Systems                                | 3                           |
| International Journal of Services and Operations Management           | 3                           |
| Journal of Operations Management                                      | 3                           |
| Business Process Management Journal                                   | 2                           |
| Computers and Industrial Engineering                                  | 2                           |
| Decision Sciences   | 2                           |
| International Journal of Integrated Supply Management                 | 2                           |
| International Journal of Lean Six Sigma                               | 2                           |
| International Journal of Logistics Research and Applications          | 2                           |
| Journal of Cleaner Production   | 2                           |
| Journal of Purchasing and Supply Management                           | 2                           |
| Logistics Research  | 2                           |
| Simulation Modelling Practice and Theory                              | 2                           |
| Symphonia   | 2                           |

**Table 1: Journals featuring citing papers**

The content of each paper was coded against the sections of the paper shown in Figure 1 to examine which aspects have been particularly used, as shown in Table 2. In a number of cases, the citing paper draws on multiple sections of the original work. Based on Naim and Gosling (2011), two further distinctions are made: the extent of use, either as a passing reference or where the paper can be seen to directly influence the research, and whether the citing authors are totally independent of Christopher and Towill and their research teams (colleagues, staff and students) or not.

|  | Total<br>Number of<br>Citations | Extent of use        |                     | Relationship to authors |           |
|--|---------------------------------|----------------------|---------------------|-------------------------|-----------|
|  |                                 | Passing<br>reference | Used in<br>research | Independent             | Dependent |
| ‘Lean’ / ‘Agile’<br>definitions        | 48                              | 47                   | 1                   | 47                      | 1         |
| Market Qualifiers<br>and Order Winners | 41                              | 28                   | 13                  | 31                      | 10        |
| ‘Lean’ / ‘Agile’<br>attributes         | 39                              | 29                   | 10                  | 33                      | 6         |
| Supply chain<br>integration            | 43                              | 37                   | 6                   | 41                      | 2         |
| De-coupling point                      | 36                              | 28                   | 8                   | 32                      | 4         |
| Migratory model                        | 16                              | 9                    | 7                   | 10                      | 6         |

**Table 2: Nature of citations for Christopher and Towill (2000)**

Despite being the main contribution, the migratory model has received far fewer citations than any of the other parts of the paper, although the citing research has developed it in more detail (as a percentage of papers) and particularly through dependent research. Most of the citing papers note that the supply chain evolves, with Borgström and Hertz (2011) showing that this process can be influenced by company strategy, economic situations, gaming by actors and functional silos.

Of the remaining sections, the definitions particularly feature as passing references. More often than not, the definition of agility is used although there are nine papers where it is used to define lean. While the MQ/OW discussion draws more on dependent citations, one interesting insight can be found in Godsell et al. (2011). They highlight that two schools of thought relating to these exist, depending upon whether supply chain strategy is set before or after these are known. This difference is evident in other citing papers, such as Reiner and Trcka (2004), where strategy comes first, and Sweeney (2011), where they are used to set strategy. However, Godsell et al. (2011) go further by proposing a framework that combines these two approaches to facilitate the development of a segmented supply chain strategy.

Considering the papers citing the attributes, Table 3 is particularly developed, both in terms of alternative attributes (for example, Ramesh and Devadasan, 2007; Lyons and Ma’aram, 2014), in other contexts such as sustainability (Carvalho et al., 2011; Dües et al., 2013; Youn et al., 2012), for additional supply chain structures (Baramichai et al., 2007; Soni and Kodali, 2009) and applied to particular products (Bakker et al., 2008). Multifarious aspects of the supply chain are developed through the citing literature, including complexity, information sharing, integration and virtuality. By contrast, the de-coupling point approach is considered less, although the emergent research makes the case for multiple decoupling points (Huang and Li, 2010), the role of capital investment in positioning these (Nieuwenhuis and Katsifou, 2015) and the importance of strategic inventory at these points (Drake and Lee, 2009). An interesting application that reinforces this can be found in the humanitarian sector, where

planning is ‘lean’, the response is agile and the de-coupling point occurs where strategic, pre-positioned inventory is held (Oloruntoba and Gray, 2006).

| <b>Distinguishing attributes</b> | <b>Lean supply</b>    | <b>Agile supply</b>    |
|----------------------------------|-----------------------|------------------------|
| Typical products                 | Commodities           | Fashion goods          |
| Marketplace demand               | Predictable           | Volatile               |
| Product variety                  | Low                   | High                   |
| Product life cycle               | Long                  | Short                  |
| Customer drivers                 | Cost                  | Availability           |
| Profit margin                    | Low                   | High                   |
| Dominant costs                   | Physical costs        | Marketability costs    |
| Stockout penalties               | Long term contractual | Immediate and volatile |
| Purchasing policy                | Buy goods             | Assign capacity        |
| Information enrichment           | Highly desirable      | Obligatory             |
| Forecasting mechanism            | Algorithmic           | Consultative           |

**Table 3: Distinguishing attributes of lean and agile supply (Mason-Jones et al., 2000)**

The above analysis of the citations gives some interesting insights, especially as such a measure is often used as a proxy for evaluating research quality (Andras, 2011). Although Table 2 only distinguishes between passing use and a detailed examination, it appears that those citations that make passing use fall in to two categories. In the first, the authors are using the paper to substantiate their arguments, even if the research is investigating a slightly different topic. The second is where there is little or no connection between the paper and the presented research. Other research (such as Salimi et al., 2015) has found that “star scientists” contribute to higher citation rates, and it may be that there are other motivations for citing a particular paper.

Further, we have identified an important construct from our detailed citation analysis. That is that the individual exploitation of such supply chain research may arise not necessarily from the final output (the Migratory Model) but from a critical preceding building block (Lean/Agile Attributes). This unexpected conclusion suggests that the importance of a paper may lie within the body of knowledge contained therein, rather than the final output. What we do not know is if this is a general or a minority result. A broad based study to determine the answer to this question is obviously a topic for further research.

### **3. Reflecting on the Migratory Model**

Given this, we now consider why the Migratory Model has not been tested further. It is clear that there are strengths in the original model. The theoretical building blocks upon which it is founded are well cited by a wide range of authors in a range of applications. Further, there is evidence that it can be transferred to industries other than the PC supply chain originally studied. However, there are weaknesses too, which raise some further questions to be addressed.

The first of these is that research often considers a firm or plant at a particular point in time and therefore ignores how the organisation reached this point, or where it might go next. The



prevalence of positivist survey research in supply chain management is also not conducive to examining this. A potentially fruitful way to examine the migration would be to pursue longitudinal studies of plants in different markets and technological environments. Such research is often suggested as being valuable in supply chain management research, but few studies are published using this approach (Boyer and Swink, 2008). One factor here may be the timeframe for the evolution to take place. In the original paper, the evolution of the PC supply chain took over 20 years, yet research timeframes are often dictated by the duration of a PhD or research project (typically 3 to 5 years).

Of the cases that we have found, they either feature well document transitions (the PC supply chain) or authors who have been embedded in the industry sectors for an extended period (Borgström and Hertz, 2011, Nieuwenhuis and Katsifou, 2015). This form of “engaged scholarship” (van de Ven, 2007, cited in Nieuwenhuis and Katsifou, 2015), which often builds up extensive but unstructured tacit knowledge to complement more formal research methods, may offer an alternative approach, but is a method rarely seen in supply chain management research.

A second weakness to be considered is whether an industry as a whole migrates or if, within a particular sector, there are firms at different stages of the migration, and also whether all firms within an industry need to evolve to survive. Some studies (such as Childerhouse and Towill, 2006) show a range of firms at different stages although the number of cases is relatively low. However, one piece of work (Narasimhan et al., 2006) has been identified that gives detailed insights into this through large scale survey based research, and is discussed in detail in the section 4 below.

Finally, while the building blocks have been tested and therefore updated through further research, the lack of an evaluation of the migratory model means that there is the potential for it to not reflect supply chain management today. This lack of recency has the potential to therefore suppress the model’s usefulness, creating a vicious circle. To address this concern, we consider the case of the book industry in section 5.

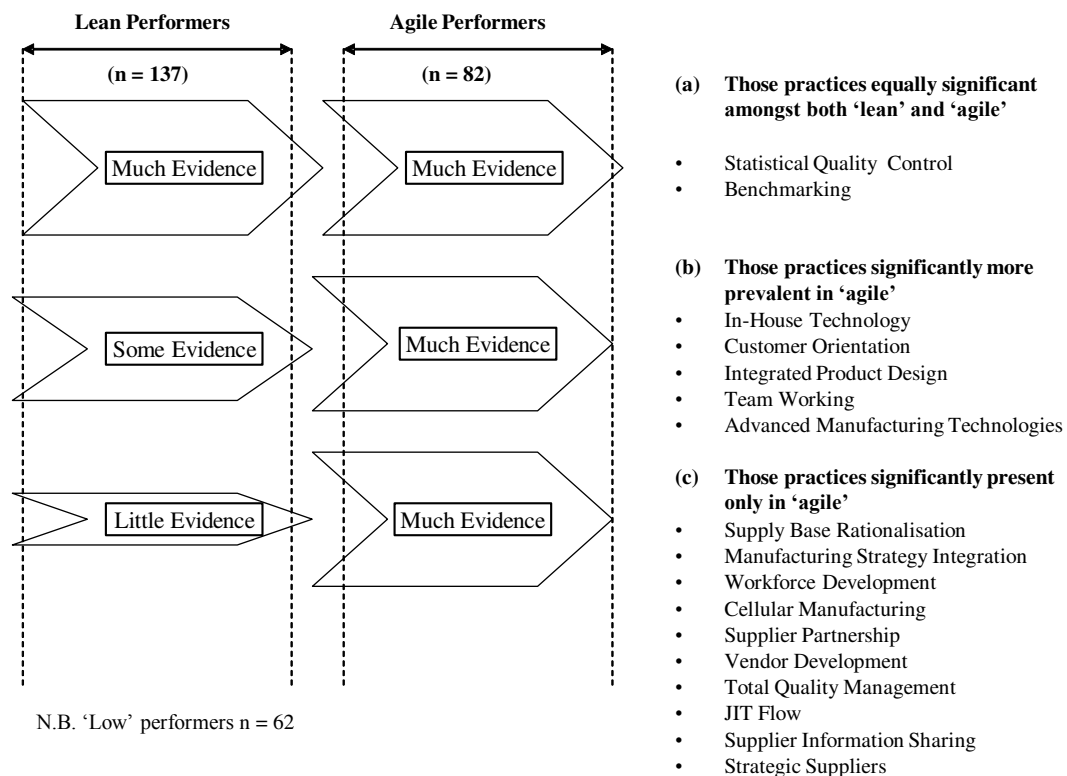
#### **4. Further exploration of lean and agile**

The original paper (Christopher and Towill, 2000) summarised the major differences between lean supply and agile supply as the set of distinguishing attributes summarised in Table 3. Agile supply is market sensitive and is thus responsive to real demand as distinct from forecast-driven operations. As Christopher (1998) explained, when IT enables comprehensive data sharing between customers and suppliers, an information based virtual supply chain is created. However, such consequential benefits can only be fully realised via process integration, which in turn necessitates a high standard of industrial systems engineering. This is typically based on the FORRIDGE Principles (Towill 1997) as widely exemplified in Towill and Gosling (2014).

The seminal paper by Narasimhan et al. (2006) cites Christopher and Towill (2000) and an associated follow-up publication (Christopher and Towill, 2001) to advantage. In particular

they point out that the findings from the statistical analysis of their extensive horizontal survey of 62 industrial 'low' performers, 137 industrial 'lean' performers (equivalent to stages I and II of the migratory model), and 82 industrial 'agile' performers (stages III and potentially IV) are consistent with the differences posited by Christopher and Towill (2000), hence underpinning the latter paper with widely based hard evidence. Of particular interest is the significant difference in Key Performance Indicators (KPIs) established between the various performer categories. Of seven KPIs analysed, 'lean' organisations were superior only along the Cost dimension. For the remaining six KPIs (Process Flexibility, New Product Flexibility, Delivery Speed, Delivery Reliability, Design Quality and Process Quality), 'agile' organisations performed better, with the greatest differences being associated with delivery and flexibility. This finding is consistent with both Cardiff and Cranfield predictions (Naylor et al 1999; Christopher and Towill, 2000, 2001; Mason-Jones et al, 2000). We note in passing that this result is a very positive indication of the high level of industrial systems engineering associated with agile processes showing that most if not all activities have been analysed and improved.

Narasimhan et al (2006) also took the 'lean' ~ 'agile' debate into new territory which considerably aids understanding of the specification, design, and operation of industrial processes. This extension summarised in Figure 3, identifying company practices found to be associated with the different categories of performers. For example it has been established that there are no practices for which lean processes are found to be dominant: in only two (statistical quality control and benchmarking practices) are they a presence sufficient to match their significance in agile processes. Furthermore there are five work practices (including customer orientation and team working) found to be significantly more prevalent in 'agile' companies. Finally, there are a further ten work practices typically found only in agile organisations, despite the fact that a number (such as JIT) are, on this evidence, wrongly associated with lean processes. In other words, various work practices claimed to be an essential precursor to lean production, are not actually incorporated until there is a need to enable agility.



**Figure 3: Company practices established to be significantly present in 'lean' and 'agile' performers (based on Narasimhan et al. 2006)**

The Narasimhan et al. (2006) empirical results indicate that the prevalence of agile and lean performing plants differs significantly across industry types, and therefore addressing one of the weaknesses of Christopher and Towill (2000) discussed earlier. However, there still appears to be substantial numbers of both types of plants in each industry thereby identified. For these plants, Narasimhan et al. (2006) argue that leanness might indeed be a precursor to agility. Harmonzi (2001) also suggests that plants move along an evolutionary path, transitioning from one performance group to another in "manufacturing phase shifts". Do plants evolve in this way? Should they seek to do so? Narasimhan et al. (2006) consider these as questions for future research, yet the earlier evidence from Christopher and Towill (2000) suggests that this migration does occur and provides further impetus for revisiting the model in the light of modern supply chain practices.

## 5. The book supply chain

In revisiting the migratory model, we consider the book supply chain, with a summary in Table 4. The mass production of books was started by Johannes Gutenberg in Mainz, Germany on 1450 (Cope, 2001) and, while centralisation and globalisation of manufacture due to improved transport networks occurred, there is evidence of this basic approach continuing into the 1990s. As KPMG (1998) report, the book supply chain in the UK at this time was beset by functional silos and a focus on unit production costs, with the result that over 60 days of stock existed within the system. Many of these characteristics reflect stage I of the migratory model.

| Supply chain evolution phase        | I  | II  | III   | IV  | Future Developments  |
|-------------------------------------|--|---|---|---|--|
| Supply chain philosophy             | Product driven   | Market orientated   | Market driven   | Customer driven   |  |
| Time marker                         | Until the 1990s  | 1990s   | 2000s   | Early 2010s   | Late 2010s   |
| Evidence from the book supply chain | Mass production of books started in 1450. Functional silos and over 60 days of stock | Focus on streamlining supply chains enabled by developments in desktop publishing | Emergence of online book retailing and e-books. Traditional bookstores tailoring product range. | Digital printing allowing short or single print runs. Customised books and self-publishing grows. | Production of single books where reader chooses content. Interactive content leads to the multichannel novel |

**Table 4: Application of migratory model to the book supply chain**

The emergence of desktop publishing software in the 1990s enabled changes to the economics of book production, reducing the composition cost of a typical textbook by 70% (Barnard, 1999). This gave opportunities to reduce batch sizes and ‘lean’ the supply chain as a whole, while maintaining in-store product ranges in the tens or even hundreds of thousands (Edwards et al., 2008). Therefore, it could be considered that stage II was reached during this time.

The widespread emergence of alternative distribution channels in the 2000s signalled the migration to Stage III of the model. Customers could now choose to visit a bookstore, order online for home delivery or download an e-book. As Cope (2001) noted, for physical copies of books, there was little change in the supply chain beyond bypassing the bookstore although with e-books there were more fundamental changes. Consequently, distinct decoupling points for each channel also emerged. The consequence of this has been the decline of the traditional bookstore, as online retailers have gained significant market share (Baye et al., 2013). However, this is also encouraging a leagile response from these retailers – in the UK, Waterstones increasingly tailors its in-store stock to reflect the local market (Key Note, 2014).

The 2010s has seen increasing levels of customisation provided in the book supply chain, for example through the provision of course specific textbooks. The quality of digital printing is beginning to meet market expectations thereby enabling smaller production runs and even print-on-demand solutions for the mass market (Holman, 2009). As a result of this, plus access to e-book distribution channels, self-publishing has emerged as a viable route to market for many authors (Key Note, 2014) further increasing the range of titles available to the market while meeting the other requirements of a customer driven strategy. While the market share for this route is relatively small and often targeted at more niche topics, there are also examples of extremely successful titles (for example James, 2012).

The above evidence would support the continuation of the migratory model in its current form, with the book industry just reaching Stage IV. It is also clear from this evolution is that, despite the many supply chain changes that have occurred, the physical book still accounts for the largest percentage of sales in this market (Key Note, 2014). Therefore, the additional supply chains are both additional and complementary to the processes started over 500 years ago. The suggestion that an industrial sector includes firms at all of the stages is further supported. However, there are other developments not mentioned above that suggest the model is in need of refinement.

Firstly, it is clear that the book industry, like many others, has embraced the sustainability agenda and this has then fed through to its supply chain. The use of recycled paper has been particularly encouraged since the 1990s (Vermaas, 2014), when the industry was in Stages I and II, while initiatives such as the Book Industry and Environmental Council (BIEC) in the USA and green4books in the UK have encouraged wider sustainability in the industry. For example, there has been an increase use of both recycled fibre content and Forest Stewardship Council certified paper over the past 2 decades (BIEC, 2014). The migration to Stages III and IV in the book industry have seen some radical changes to the supply chain structure and, while there are suggestions that these improve environmental performance, there has been some research that suggests a more mixed picture for both online retailing (Edwards et al., 2010) and e-books (Vermaas, 2014). Regardless, the environment or sustainability does not feature in the migratory model.

Secondly, it is necessary to look at developments that are emerging on the horizon that may affect the supply chain further. Cope (2001) had a vision that books in the future would be fully customised, available through multiple distribution channels, have a totally automated supply chain and, for physical copies, be able to economically support a print run of one. Digital printing technology, including its supporting IT systems, continues to advance, enabling customisation to suit particular markets and the viable printing of single copies (Pate and Tan, 2014). The multichannel novel is emerging, where the book (both physical and electronic) is embedded in a wider, online presence including games and social media (Key Note, 2014). This servitisation of the novel offers opportunities for publishers to develop stronger links with customer and grow their revenue streams through, for example, in-game purchases. What is clear is that the level of focus on the customer is likely to be greater than currently suggested by the migratory model, with a consequential impact on OW and MQ.

## **5. The Migratory Model revisited**

The past fifteen years have seen significant developments, and not just in the book industry, with the emergence of sustainability as a core business requirement, substantial technological developments and growing global trade and economic development. However, many supply chain management principles remain fundamentally similar, perhaps illustrated by the continuing presence of lean and agile in the literature. Given this, we present an updated Migratory Model in Table 5.

| <b>Supply chain evolution phase</b> | <b>I</b>  | <b>II</b>  | <b>III</b>                                     | <b>IV</b>   | <b>V</b>   |
|-------------------------------------|---|--|--|---|--|
| <b>Supply chain philosophy</b>      | Product driven                                      | Market orientated                                      | Market driven                                  | Customer driven                                   | Customer centric                                   |
| <b>Supply chain type</b>            | Lean functional silos                               | Lean supply chain                                      | Leagile supply chain                           | Customised leagile supply chain                   | Multiple leagile supply chains                     |
| <b>Order Winner</b>                 | Quality   | Cost   | Availability                                   | Lead time   | Lead time  |
| <b>Market Qualifiers</b>            | Cost<br>Availability<br>Lead time<br>Sustainability | Availability<br>Lead time<br>Sustainability<br>Quality | Lead time<br>Sustainability<br>Quality<br>Cost | Sustainability<br>Quality<br>Cost<br>Availability | Sustainability<br>Quality<br>Cost<br>Availability  |
| <b>Performance metrics</b>          | Stock turns<br>Production cost                      | Throughput time<br>Physical cost                       | Market share<br>Total cost                     | Customer satisfaction<br>Value Added              | Technological capability<br>Level of Servitisation |

**Table 5: Updated Migratory Model**

Stages I to IV remain the same as previously, save for the inclusion of sustainability as an additional MQ. Despite growing interest in this area, it could not yet be considered universally as an OW. However, there is no doubt that it has emerged as an important issue when determining supply chain strategy for leading organisations (Walker and Jones, 2012). Further, unlike other MQ and OW criteria, the level of sustainability should not vary across the different stages of the migratory model. We now also add Stage V to take into account further supply chain developments since the original paper was published, as evidenced in the book supply chain.

This stage can be considered ‘customer centric’ where the customer does more than just choose from limited options given by the supply chain. Instead, they are more heavily involved in actually specifying the supply chain (Abney, 2014), exploiting the opportunities arising from increasing technological power. At one extreme of the supply chain, we are witnessing the rise of omnichannel retailing, where the distinction between physical and online supply chains is disappearing (Brynjolfsson et al., 2013). Customers can choose how, when and where they want to get their products from, requiring multiple integrated supply chains to achieve this. Effectively, this is a distribute-to-order strategy. At the other extreme, changing manufacturing technologies have the potential for customers to effectively engineer-to-order the products they need (Anderson, 2013). If this can be incorporated into larger scale production systems, then there is the potential to challenge the traditional manufacturing strategy trade-offs between volume and variety (Tuck et al., 2008). Evidence for this happening, however, is limited to date. Being ‘customer centric’ is likely to require structural flexibility, where the supply chain can adapt to fundamental change. In doing so, exploiting economies of scope and making use of shared assets will become important supply chain strategies.

The OW and MQ criteria are identical to stage IV in name, but customers are more exacting in stage V. Lead times remain the OW and need to be similar or the same for all delivery routes. However, customers also expect little or no cost difference between these channels,

which is already creating challenges for retailers (Ahmed, 2015, Espiner, 2015) and logistics providers (Stead, 2015) and may not be economically sustainable in the long term. Availability requirements have become more exacting, given the ease with which customers can switch between retailers in an online environment. As Brynjolfsson et al. (2013) note, traditional barriers that retained customers for retailers, such as geography or a lack of awareness, no longer exist with online supply chains. Finally, quality remains an important MQ, and depending upon the nature of the supply chain evolution, may actually prohibit a move to stage V. As discussed earlier, quality has been an issue with the move to print-on-demand book titles and is also a potential issue with current additive manufacturing technologies (Holmström, J. and Partanen, J., 2014).

Turning to the performance metrics, these have moved away from traditional measures of supply chain performance to recognise some of the underlying principles that contribute to a customer centric focus. As has already been discussed, technology is a key enabler. This builds on the use of advanced manufacturing technologies found by Narasimhan et al. (2006) in agile organisations. Technology needs to be provided to provide the required information throughout the supply chain, including the customer. The other measure is the level of servitisation. This concept has become increasingly important for manufacturing organisation (Baines et al., 2009) and recognises that additional customer value and revenue for the supply chain can be generated providing services to complement the physical product (such as the multichannel book concept). Customer centricity is not just about involving the customer in supply chain decision making but building relationships with them, with servitisation having a key role in this.

## **7. Discussion**

The above discussion highlights a number of important aspects for supply chain management going forwards. At a strategic level, it is clear that if looking at a sector as a whole, an evolutionary path emerges. However, how this translates to firm level actions varies. For some firms, their evolution reflects that of the sector as a whole, although they may not be at the forefront of this. Often, these are the larger players in a sector – in the book supply chain, an example would be the major publishers who are beginning to adopt the ‘print-on-demand’ and multichannel novels. However, smaller players can occupy distinct niches although their relative market shares are influenced by changes in the market as a whole. Traditional bookstores may be declining, but they still service a particular niche. Likewise, the self-publishing route has created new players within the industry. Consequently, a diverse picture emerges of firms at different stages, as witnessed by Narasimhan et al. (2006).

In terms of achieving a customer centric strategy, it is clear that technology has an important role to play. However, the extent to which this is moving decoupling points is limited both in terms of scale and also sectors. Additive manufacturing currently offers opportunities for small scale production items but there is less evidence of it radically changing higher volume supply chains. Likewise, digital printing does not see extensive use currently. Therefore, decoupling points for many products remains close to the customer. Thinking back to the PC supply chain example from the 2000 paper, the modular approach of Dell has been

supplemented by omnichannel retailing routes, but customers are not yet able to influence the design of the components making up the modules.

Finally, in terms of the tools that support this transformation, there is still a reliance on traditional industrial engineering approaches that can be traced back through the FORRIDGE principles to the work of the Gilbreths and others in the early 20<sup>th</sup> century (Towill, 2010). The work of Narasimhan et al. (2006) shows how these are deployed generally within both lean and agile contexts, while KPMG (1998) considers how, at that point in time, the book supply chain could be improved using such tools. Despite the disruptive introduction of new players into this sector (such as Amazon), it has taken time for the more established supply chain members to catch up because of the need to not just change strategy but re-engineer the supply chain to align with this.

## 8. Conclusion

This paper has revisited the migratory model first put forwards at the start of the 21<sup>st</sup> century, considering the extent to which it has influenced academic thinking and evaluating its continued relevance in a much changed world. While it has received a steady flow of citations, the majority of these are not directly related to the migratory model. However, there is continued relevance for a migratory perspective, and in 2015 it is apparent that technology has enabled a fifth stage to emerge. Supply chains are increasingly customer centric and, as such, the customer is far more engaged in decisions within the supply chain. This requires organisations to be more responsive, for which technology can assist. However, there is also pressure on supply chains as many of the traditional supply chain metrics, such as cost, remain critical.

Looking forwards, there appears to be a continuing need for research that examines the longer term evolution of supply chains, understanding the factors that influence this and the tools used at an operational level to deliver the changing strategy. As highlighted earlier, established research methods may need to be complemented by those that are less common in supply chain management research. Another challenge will be the extent to which manufacturing technologies such as additive manufacturing can redefine supply chain strategies vis-à-vis where they just replace existing production technologies. Undoubtedly, such research areas will contribute to the continued development of supply chain management as a theory.

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